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ANALYSIS

OF

THE CONGRESS SPRING OF SARATOGA IN AMERICA.

The reputation which this Spring enjoys through the number of invalids who annually resort to it for the benefit of their health, has induced me to analyze its Mineral water with a view to prepare it for dispensation at the Royal German Spa. The process which I adopted to ascertain the nature and the quantity of the ingredients I will briefly relate, thus enabling the enquirer to judge what reliance may be placed on its correctness.

The Mineral water, which I obtained through the kindness of Dr. Todd, had been bottled with all due caution, a fact of which I was convinced from the water being so pellucid and so abundant in gas, whilst only a trace of the peroxide of iron was found as sediment. It is also of importance to notice that the Mineral water was contained in very strong dark-green 1½ pint glass bottles, which were well corked, wired and resined, and that only such water was submitted to analysis as was held in perfectly sound bottles, entirely free from any tracc of escape or leakage.

PHYSICAL EXAMINATION.

The Mineral water has a slightly saline taste, leaving an after-taste of magnesia on the palate. It is very transparent and colourless; when a bottle is opened, many gas bubbles rise to the surface, and when the water is exposed to the air, a white sediment, in proportion to the escape of the gas, will be formed, which appears at first as a little film on the surface of the Mineral water. The water after being deprived of its gas either by shaking or by exposure to the air, has a flat insipid taste. The natural temperature of the Spring, according to Dr. Steel* (page 82,) is 50° F., and its specific gravity, according to my examination (having weighed the water with its full quantity of gas, four different times, from different bottles) was almost invariably, at 60° F., 1.00396, but if the gas was previously allowed to escape, the specific gravity, at the above temperature, amounted to 1.00530.

CHEMICAL EXAMINATION OF THE SARATOGA CONGRESS SPRING.

A.—EXPERIMENTS WITH TESTS, TO ASCERTAIN THE CHEMICAL INGREDIENTS.

1.—A few drops of Tincture of Litmus reddened the Mineral water; but after heating the same, the Litmus turned blue again. A few drops of Lime water likewise produced a precipitate, which was dissolved again, until the addition of the Lime water was increased; both tests proving the presence of free carbonic acid gas.

2.—Turmeric paper turned brown when immersed into the concentrated Mineral water; proving the presence of an Alkali.

3.—Nitrate of silver showed the presence of Chlorine in the filtered Mineral water; and as the precipitate was entirely white, and the water above it remained colorless, the absence of Hydrosulphuric acid and of organic matter was substantiated.

4.—A concentrated solution of the soluble salts of the Mineral water was mixed with a solution of starch, and by the addition of nitrous acid, the presence of Iodine was satisfactorily proved.

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* An Analysis of the Mineral Waters of Saratoga and Ballston, &c., by John H. Steel, M.D., 1831.

5.—After the separation of the Iodine by a method which is elucidated in analysis III., the solution of the salts was treated with Chlorine Gas and agitated with Ether, which assumed an orange color; indicating the presence of Bromine.

6.—The presence of nitric acid was ascertained, when the concentrated Mineral water was strained from the earthy carbonates, and the Chlorides changed into Sulphates by Sulphate of Silver. The liquid, separated from the Chloride of Silver and mixed with a few drops of a Solution of Indigo, lost its blue color instantly, by the addition of pure concentrated Sulphuric acid, which had been previously boiled for a considerable time to free it from every trace of nitric acid. A portion of the Mineral water was evaporated in a water bath to dryness, and the residue dissolved in water; the liquid was again evaporated to dryness, and the residue having been mixed with copper filings and Sulphuric acid, exhaled vapours of nitrous Gas, on heat being applied.

7.—Chloride of Barium indicated Sulphuric acid; but as the quantity is minute, it was necessary to concentrate the Mineral water for an immediate visible reaction.

8.—A portion of the dry Salts, obtained by the evaporation of the Mineral water, was dissolved in water; the liquid, supersaturated with Nitric acid, gave, when precipitated with an excess of Nitrate of Silver and separated by filtration from the Chloride of Silver, no indication of Phosphoric acid, after the liquid had been duly neutralised by Ammonia. Another portion of the dry Salts dissolved in water, supersaturated by Nitric acid, precipitated by Chloride of Barium, and then strained off, proved the absence of Phosphoric acid, when the liquid was saturated by Ammonia.

9.—The Mineral water was saturated with acetic acid, and evaporated to dryness; the residue, when mixed with Sulphuric acid and heated in a platinum crucible, which was covered with a wet watch glass, gave no indication of Silico-hydrofluoric or Fluoric acid, as the watch glass remained free from any corrosion.

10.—The earthy carbonates, obtained by the evaporation of the Mineral water, left Silica behind, when dissolved in Hydrochloric acid.

11.—Ferro-cyanate of Potash indicated iron in the Hydrochloric solution of the earthy carbonates. Tincture of Gallnut produced a very slight purple tinge, when dropped into the Mineral water; but when the Mineral water was exposed to the air, or boiled, no indication of iron was perceptible. Some of the Mineral water was found to contain no iron; but its presence was ascertained when the bottle was rinsed with diluted Hydrochloric acid, thus proving that the iron exists in the form of a Proto carbonate.

12.—The Hydrochloric solution of the earthy carbonates yielded a precipitate when treated with Ammonia, and the precipitate, when boiled with caustic potash and decomposed by Hydrochlorate of Ammonia, yielded Alumina.

13.—The earthy carbonates dissolved in Hydrochloric acid, when mixed with a saturated solution of Sulphate of Lime, gave a precipitate, soluble in Hydrochloric acid; thus proving the presence of Strontia.

14.—The Silico-hydrofluoric acid produced no crystalline precipitate, when mixed with a concentrated solution of the earthy carbonates in Hydrochloric acid; proving the absence of Barytes, which is also confirmed by experiment 13.

15.—Oxalate of Ammonia indicated Lime by producing a copious white precipitate in the Mineral water.

16.—The liquid strained off from the Oxalate of Lime, gave a precipitate, when mixed with Ammonia and Phosphate of Ammonia; thus proving the presence of Magnesia.

17.—The earthy carbonates mixed with Carbonate of Soda and submitted to the action of the blow-pipe on platinum, yielded a green bead; thus proving the presence of Manganese.

18.—The Mineral water when slightly supersaturated by Hydrochloric acid and concentrated by evaporation, gave no precipitate with Hydrosulphuric acid; proving the absence of every metal affected by that test.

19.—A glass rod, wetted with Hydrochloric acid, being held over the surface of the concentrated Mineral water, which was mixed with an adequate quantity of Caustic Soda, produced fumes indicating the presence of Ammonia.

20.—The dry residue of the Mineral water was ignited and dissolved in boiling water; the alkaline solution saturated with Hydrochloric acid was separated from the Sulphuric acid and the Magnesia, by Chloride and Hydrate of Barytes. The boiling fluid strained off from the precipitate was evaporated to dryness, and the residue dissolved in a weak solution of Carbonate of Ammonia, in order to separate the Barytes, which had been added in superabundance. The Ammoniacal fluid was freed from a trace of Lime by Oxalate of Ammonia, and after evaporation and ignition, left the alkaline Chlorides. One part of the latter dissolved in water and evaporated to dryness, with the addition of Phosphate of Soda, evinced the absence of Lithia, by the perfect solution of the residue in water.

21.—Another part of the dissolved alkaline Chlorides was mixed with an adequate quantity of Perchloride of Platinum, and evaporated to dryness by gentle heat. The residue, when dissolved in spirit of wine, left a yellow crystalline precipitate, which, when heated to full redness, disengaged Chlorine Gas and left metallic Platinum and Chloride of Potassium; thus proving the presence of Potassa.

22.—The fluid separated from the Potassio-Chloride of Platinum left, after evaporating the spirit of wine, Sodio-Chloride of Platinum; thus proving the presence of Soda.

According to the foregoing experiments, the Saratoga Congress Spring contains the following ingredients:—

Potassa, Soda, Ammonia, Lime, Magnesia, Strontia, Protoxide of Iron and of Manganese, Alumina, Silica, Carbonic acid, Sulphuric acid, Nitric acid, Iodine, Bromine, and Chlorine.

B.—EXAMINATION OF THE GASEOUS CONTENTS OF THE MINERAL WATER.

As the Mineral water abounds in Gas, only a small quantity amounting to 2.818 cub. in. was introduced into a proper apparatus and gradually heated to boiling, in which state it was kept until no further discharge of Gas was perceptible. The Gas collected over mercury measured 3.323 cub. in. in a dry state, (according to the average of three experiments, viz., 3.417, 3.277, 3.275) at 60 deg. temperature, and 30 in. barom., and was nearly absorbed by a solution of caustic Soda, leaving a residue of 0.038 cub. in., (as the average of three experiments, 0.036, 0.038, 0.040) a reduction being made for the elasticity of the aqueous vapour. The Gas absorbed by the caustic Soda was Corbonic acid Gas; the residue, not absorbed, proved to be atmospheric air after the detonation with hydrogen in the Eudiometer; a very small surplus of Azote may be considered as the product of a partial decomposition of the atmospheric air by the Protoxide of Iron. The existence of very small quantities of Azote may generally be traced to this source. Larger portions may be accounted for according to Bischoff,* who says, in his interesting treatise on the manner in which the subterranean waters become charged with Gases: "Meteoric water, flowing into vast subterranean caverns, may meet a stratum of air, which being compressed above the water will become absorbed by it. Should the water descend to such a depth that its temperature increases, it will readily part with its oxygen of the atmospheric air, if it comes in contact with organic remains, whereby carbonic acid Gas may be formed and Azote remains freed from the Oxygen."

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* Poggendorff's Annalen der Physik und Chemie, xxxii. p. 241.

Thus one pint, 34.659 cub. in., or 8785.0 gr., was found to contain 40.403 cub. in. of dry carbonic acid Gas at 60 deg. Therm. and 30 in Bar. in a free state, and 0.467 cub. in. of atmospheric air.

C.—CHEMICAL ANALYSIS OF THE SOLID CONTENTS OF THE MINERAL WATER.

Preliminary Remarks:—The precipitants and tests used for the Analysis are of my own preparing. The vessels used during the operation consisted partly of glass free from lead, partly of Berlin porcelain, and partly of platinum. The filtering paper was of Swedish manufacture, containing in the average 0.707 per cent. of ashes. The filter was burnt and ignited with the precipitate, when the latter was of a nature to admit of the operation, and the ashes deducted from the total weight; but whenever the precipitate had to undergo a further examination, the filter was freed, as far as possible, from the precipitate, the weight of the latter ascertained, and also that of the filter with the remainder of the precipitate separately.

The substances when ignited were always allowed, before being weighed, to cool, protected from the atmospheric air. The equivalent numbers have been computed according to the tables which H. Rose has affixed to his *Handbuch der analytischen Chemie* (Zweiter Band, Zweite Auflage, 1831). The numbers in these tables are computed from the equivalents of the elementary substances according to the latest experiments of Berzelius.*

I.—10000 gr. of the Mineral water, supersaturated with Hydrochloric acid and precipitated with Chloride of Barytes, gave 3.2000 gr. Sulphate of Barytes, making for 1000 gr. of the Mineral water, 0.32000 gr., being equal to 0.01100 gr. of Sulphuric acid.

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* Poggendorff's Annalen der Physik und Chemie, Bd. xiv. p. 566.

II.—10000 gr. of the Mineral water supersaturated with Nitric acid and precipitated with Nitrate of Silver, gave 89.620 gr. of a precipitate of Silver, making for 1000 gr. of the Mineral water, 8.96207 gr. of that precipitate; but as will be seen hereafter, 0.0514, gr. of Bromide of Silver, and 0.00122 gr. of Iodide of Silver are to be deducted from the amount (8.96207—0.05263) leaving 8.90944 gr., equal to 2.19795 gr. of Chlorine.

III.—Before I enter upon the process for ascertaining the quantity of Iodine and Bromine, I will explain my reasons for selecting it. When small quantities of Bromine and Iodine are accompanied by a large proportion of Chlorine, it is impossible, according to my knowledge, to ascertain Bromine by a direct experiment. If the usual experiment be resorted to, that is, the introducing Chlorine into the concentrated Solution of the Salts, and then agitating it with Ether, (which separates itself upon the surface, holding in solution the Bromine) it will also contain Iodine, and the coloring of the Ether will be no criterion, particularly as Iodine has a greater coloring property than Bromine. I therefore consider this test of Bromine fallacious, and only to be relied on when the absence of Iodine has been previously established. An Iodide will not alone be decomposed by free Chlorine, but also by free Bromine. I have ascertained that when Bromine is introduced into a solution of an Iodide, and then treated with Ether, the Ether will contain the entire quantity of Iodine, (provided Bromine has been sufficiently added) and the remaining liquid will contain a Bromide free from Iodide, which is easily ascertained by means of a solution of Starch, etc. Iodide of Silver, when melted in an atmosphere of Bromine, will be perfectly changed into a Bromide. This method may be adopted to ascertain the quantity of Iodine when mixed with Bromine, as, in like manner, H. Rose* ascertained the quantity of Iodine when mixed with Chlorine. The foregoing experiments will satisfactorily prove that the above method for separating Bromine from Iodine is inapplicable. The following process for the separation of Iodine, Bromine, and Chlorine in Mineral waters containing the former substances in very small quantities, has given me satisfactory results, which were borne out by previous experiments. 100000 gr. of the Mineral water were evaporated carefully in a water bath to

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* Poggendorff's Annalen der Physik und Chemie, 1831, xxxvii. p. 583.

about eight ounces, with a sufficient addition of caustic Soda The fluid, strained off from the earthy carbonates, was evaporated to dryness, and again dissolved in water, which process was repeated until the residue dissolved perfectly in water. The solution of these Salts was perfectly neutralised by Hydrochloric acid; and to the fluid (kept in a concentrated state, in about the proportion of 30 of salt to 100 of water) was very carefully added a solution of pure Chloride of Silver in Ammonia, prepared as follows:—one part of a concentrated solution of fresh precipitated Chloride of Silver was mixed with one part of Ammonia and two parts of water. One or two drops of this mixture, when added to a concentrated solution of Chloride of Sodium, containing in thirty parts of its weight one part of Bromide of Sodium, must leave the solution clear after agitation; if it produces a turbid appearance, Ammonia and water are to be added to the solution of the Chloride of Silver, until the point is attained. The quantity of Ammonia to be used depends on its strength. This test, which leaves the above solution of the Chloride and Bromide Salt clear, will indicate, by a turbid appearance, the minutest quantity of an Iodide, presuming no more Ammonia has been added than is just required to produce the above appearance. A solution of Chloride of Silver thus prepared was added, drop by drop, to the above solution of the Salts of the Mineral water, and one drop was not added until the turbidness produced by the last had subsided. If no further turbidness is produced by an additional drop, the Iodine is to be considered entirely separated in the form of Iodide of Silver; which can be proved by applying a solution of Starch, the usual test for Iodine. It is of course necessary during the precipitation to keep the vessel perfectly closed, to prevent the evaporation of the Ammonia. The fluid was decanted as far as possible from the Iodide of Silver, and the remainder put upon a small filter. The Iodide of Silver was first lixiviated with a little well-diluted Ammonia and afterwards with a few drops of diluted Hydrochloric acid, to remove any doubt of the presence of an earthy carbonate in the precipitate. The filter with the precipitate was dried and ignited. This experiment, repeatedly performed, always yielded me the most satisfactory results; it requires time and close observation, but this is more than balanced by the accuracy it affords. Thus was obtained 0.12164 gr. of Iodide of Silver, making for 1000 gr. of the Mineral water
7 / 0.0012~~6~~ gr., equal to 0.00067 gr. of Iodine.

IV.—The Ammoniacal Fluid, separated from the Iodide of

Silver, was carefully evaporated, to expel the Ammonia, whereby a small precipitate was obtained consisting of Bromide of silver,* the weight of which was added to that hereafter obtained. This precipitate was formed by the solution of the Chloride of Silver, more of which was added than was required for the separation of the Iodine. The concentrated solution was again mixed with a few drops of the ammoniacal solution of the Chloride of Silver which was thus prepared:—One Part of a concentrated Solution of Chloride of Silver in Ammonia, mixed with one part of Ammonia and one part of water. A few drops of this mixture produced no turbidness in a concentrated solution of Chloride of Sodium, but indicated a very minute quantity of a Bromine, by which means the Bromine was separated from the Chlorides as Bromide of Silver, under the same precaution observed with regard to the separation of the Iodine. When no further turbidness was produced by an additional drop of the ammoniacal solution of the Chloride of Silver, a small quantity of the fluid was tested with Chlorine and Ether; if the slightest yellow tinge appears, a very little addition of water will again produce turbidness. The turbidness having subsided, a small portion of the liquid must be tested again for Bromine; and if an indication of it be perceptible, a few drops of the solution of the Chloride of Silver are to be added, and by pursuing this method the Bromine will be separated as Bromide of Silver. The small quantities of the fluid thus used for testing Bromine were collected, neutralized, and heated, in order to expel the Ether, and then again mixed with the whole. The precipitate obtained was lixiviated with a small quantity of very dilute Ammonia, and its quantity ascertained as with the Iodide of Silver. Thus it yielded 5.141 gr. of Bromide of Silver, making for 1000 gr. of the Mineral Water, 0.05141 gr. —equivalent to 0.02158 gr. of Bromine. If this method be carefully pursued, the Bromine will be entirely separated, and I found, by repeated experiments, the result to deviate, by the above quantity, only in the second decimal fraction of the Silver precipitate.

V.—50000 gr. of the Mineral Water were evaporated in a water bath to about 8 oz.; the fluid was strained off, and the earthy residue perfectly lixiviated with boiling water. The fluids obtained were mixed and neutralized by Sulphuric Acid and digested with a due quantity of Sulphate of Silver* in order to change the Chlorides into Sulphates. The fluid separated from the Chloride of Silver was concentrated and boiled for half an hour in a proper apparatus with pure concentrated Sulphuric Acid, which had previously been boiled for some time. The vapor was conducted into a glass receiver, which was connected with another, both containing a solution of Hydrate of Barytes. These fluids were then exposed for some time to an atmosphere of Carbonic Acid Gas, in order to convert the Hydrate of Barytes into a Carbonate of Barytes, and were evaporated to dryness; the residue was lixiviated, and the fluids, when precipitated with Sulphuric Acid, gave 1.360 gr. of Sulphate of Barytes, which is proportionate for 1000 gr. of the Mineral Water, to 0.03048 gr. of Nitrate of Barytes, equal to 0.01262 gr. of Nitric Acid.

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* That this minute precipitate consisted of Bromide of Silver, was proved by heating it in a test tube with pure concentrated Sulphuric Acid, whereby it became of a delicate yellow colour; whereas Chloride of Silver would have remained white and Iodide of Silver would have obtained a brown colour by its parting with Iodine.

VI.—50000 grs. of the Mineral Water were slightly supersaturated with Hydrochloric Acid and evaporated to 6 oz. The fluid was put into an appropriate glass retort and mixed and distilled with caustic Soda, which had previously been boiled, The vapor was conducted into a glass receiver, containing diluted Hydrochloric Acid. The acid fluid was carefully evaporated to dryness at a temperature below 212 deg., and the weight of the residue was only then taken when no further loss occurred. The crucible containing the Chloride of Ammonium was heated and the latter thus volatilised. The difference of the weight denoted the actual quantity of the Chloride of Ammonium, which amounted to 0.28300 gr., making for 1000 gr. of the Mineral Water 0.00566 gr., equal to 0.00181 gr. of Ammonia.

VII.—100000 gr. of the Mineral Water were evaporated to dryness in a water bath, the residue perfectly lixiviated with boiling water, and the saline solution again evaporated to dryness and heated over a spirit lamp, in order to decompose the Soda-carbonate of Magnesia, which might have been formed. The heated substance when treated with boiling water left some earthy carbonates. The saline solution was again evaporated, and the residue again dissolved; which process was repeated until the saline residue dissolved perfectly in water. The earthy carbonates were added to those obtained by the first lixiviation, and the whole of them dissolved in Nitric Acid, to which was added that which adhered to the sides of the bottles, which had been rinsed with Nitric Acid. They were dissolved in a platinum crucible, covered with a watch glass, to prevent any loss during the effervescence, and likewise to shew whether any Fluoric Acid were present; but no corrosion of the glass took place, even when the fluid was evaporated to dryness. The residue macerated for 24 hours with Nitric Acid, and lixiviated with water, left 1.930 gr. of Silica, which, for 1000 gr. of the water, makes 0.01930 gr. of Silica.

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* The Sulphate of Silver was prepared by boiling pure Silver with pure Sulphuric Acid.

VIII.—The Nitric solution obtained in VII. was precipitated in a closed vessel by Ammonia, and the fluid, strained off from the precipitate, kept for further examination. The precipitate was dissolved in Hydrochloric Acid, and after being mixed with a solution of Chloride of Ammonium was again precipitated in a closed vessel by Ammonia. The precipitate quickly separated from the fluid (which was then added to the former), was dissolved in Hydrochloric Acid and decomposed by caustic Soda. The caustic fluid, separated from the precipitate, yielded, when neutralised with Hydrochloric Acid and precipitated by Carbonate of Ammonia, 0.121 gr. of Alumina, making, for 1000 gr. of the water, 0.00121 gr. of Alumina.

IX.—The precipitate, separated from the caustic fluid in VIII., was dissolved in Hydrochloric Acid and very carefully neutralized with Ammonia; the fluid was precipitated by Succinate of Ammonia, which was kept perfectly neutral, and the precipitate, when lixiviated with water and diluted Ammonia, yielded after ignition, 0.207 gr. of Peroxide of Iron, which, for 1000 grs. of the water, is equivalent to 0.00185 gr. of Protoxide of Iron.

X.—The fluid obtained in IX. was, during ebullition, mixed and precipitated with carbonate of Soda, until the escape of Ammonia was no longer perceptible and carbonate of Soda was predominant. The precipitate gave, after lixiviation with boiling water and ignition, 0.2348 gr. of red oxide of Manganese, which, for 1000 gr. of the Mineral water, is equivalent to 0,00218 gr. of Protoxide of Manganese.

XI.—The ammoniacal fluids obtained in VIII., appropriately diluted, were precipitated by oxalate of Ammonia.* The precipitate, when lixiviated and carefully ignited with an addition of carbonate of Ammonia, yielded 102.690 gr. of carbonate of Lime and Strontia. 102 gr. of it were used for further examination, (a due calculation being made for the ingredients of 0.690 gr.) They were dissolved in Nitric acid, and the acid solution was evaporated in a water bath to dryness. The Nitrates, when macerated with a due quantity of Alcohol at a specific gravity of 0.793, left a residue, which after lixiviating it with Alcohol, dissolving it in water, precipitating it by oxalate of Ammonia, and igniting it to a carbonate, gave 1.167 gr. of carbonate of Strontia, making, for 1000 gr. of the water, 0.01167 gr., equal to 0.00818 gr. of Strontia (including the due proportion of Strontia for the 0.690 gr.) The precipitate dissolved perfectly in Hydrochloric acid, and being evaporated to dryness and dissolved in Alcohol, displayed, when applied to a cotton wick and ignited, the characteristic red flame of Strontia.

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* When large quantities of Lime and Magnesia are to be separated from each other, the solution must be well diluted, (after having received its due proportion of an ammoniacal salt) and mixed with Oxalate of Ammonia, until precipitation ceases. The whole must be slightly warmed, and, after it has cooled again, is to be tried with Oxalate of Ammonia, until precipitation no longer takes place. Thus the precipitation of Magnesia is obviated.

XII.—The Alcoholic solution of the nitrate of Lime, freed from the nitrate of Strontia in XI., was evaporated to dryness, dissolved in water and precipitated by oxalate of Ammonia, The oxalate of Lime, when converted into sulphate of Lime, weighed 137.723 gr., equivalent to 101.616 gr. of carbonate of Lime, and making, for 1000 gr. of the water, 1.01616 gr., equal to 0.57201 gr. of Lime. If we deduct from the general amount of the carbonate of Lime and Strontia, obtained in XI., the weight of the carbonate of Strontia (102.690—1.167) there will remain 101.523 gr. for the carbonate of Lime. The difference between this and the above quantity of the carbonate of Lime (amounting to 0.09 gr.) is very small, considering that so large a quantity of carbonate of Lime may disengage a portion of its carbonic acid Gas, during the ignition.

XIII.—The fluid separated from the oxalates in XI., was precipitated by Ammonia and phosphate of Ammonia. The Ammonia-phosphate of Magnesia, when lixiviated with water, containing about four per cent. of Ammonia, (whereby the solution of the precipitate is entirely prevented) left, after ignition, 95.626 gr. of phosphate of Magnesia, which, computed for 1000 gr. of the Mineral water, gives 0.95626 gr., equal to 0.35067 gr. of Magnesia.

XIV.—The solution of the alkaline Salts, obtained in VII. by the separation of the earthy carbonates, was evaporated to dryness and then found to weigh 389.1 gr. One-third of the residue was dissolved in water and the fluid obtained was neutralised by Hydrochloric acid, and precipitated, first by Chloride of Barytes, and then by Carbonate of Ammonia. The fluid, separated from the precipitate, was evaporated, and the residue, when ignited (in order to expel the Ammonia), gave Chlorides of Potassium and Sodium, which were mixed, according to Berzelius's method, with $3\frac{3}{4}$ times their weight of crystallized Sodio-chloride of Platinum. The mixture was dissolved in a small quantity of water, and the fluid evaporated in a water bath to dryness. The residue, macerated with spirit of wine (containing 60 per cent. of Alcohol) left Potassio-chloride of Platinum, which, when washed with Alcohol and dried in a water bath, weighed 32.834 gr.. equal to 10.089 gr. of Chloride of Potassium, making for 1000 gr. of the water 0.30269 gr., equal to 0.19149 gr. of Potassa.

XV.—If we arrange the above ingredients, found in the solution of the Alkaline Salts, into binary combinations, according to their predominant chemical affinities, Potash will be found to combine with the whole amount of the Sulphuric Acid, the remainder of Potash as Potassium with Chlorine, Ammonia with Chlorine as Chloride of Ammonium, Bromine and Iodine with Sodium; and if we unite the surplus of the Chlorine with Sodium, we shall obtain by computation 375.4 gr. of those ingredients in 100000 gr. of the water. But as we have seen that the Alkaline Salts contain carbonate of Soda, the difference between 375.4 gr. and the whole weight of the Alkaline Salts obtained in XIV, amounting to 389.1 gr., will furnish us with the quantity of Carbonate of Soda, viz., 13.7 gr. To prove the correctness of the calculation by a direct experiment, the remaining $\frac{2}{3}$ of the Alkaline Salts in XIV. were dissolved, and a solution of Sulphate of Zinc was added until no further precipitation took place. The mixture was boiled for some time in order to separate the Carbonate of Zinc, which, when lixiviated with boiling water until the fluid gave no indication of Sulphuric Acid, left, after ignition, 10.015 gr. of Oxide of Zinc, equal to 9.561 gr. of Carbonate of Soda, making, for 100000 gr. of the water, 14.342 gr., which quantity corresponds very closely with the above 13.7 gr. It is here to be remarked, that, in order to separate the last traces of Magnesia from the Alkaline Salts, a temperature above 212 deg. was required, whereby not alone the Ammoniacal Salt escaped, but also a disengagement of Bromine took place, on account of which the weight of the Alkaline Salts must of course exceed 389.1 gr. The amount of the Nitric Acid, which is probably united with the Magnesia, has not been taken into account in the above calculation, as this must also have undergone a decomposition. The Soda, combined with Iodine, Bromine, Chlorine and Carbonic Acid Gas, will therefore amount to 191.320 gr., making, for 1000 gr, of the Mineral Water 1.91320, gr. of Soda.

The solid ingredients obtained by the foregoing Analysis and calculated for 1000 grains of the Spring, will amount to—

Potassa	0.19149
Soda	1.91320
Ammonia	0.00181
Lime	0.57201
Magnesia	0.35067
Strontia	0.00818
Protoxide of Iron	0.00185
Ditto of Manganese	0.00218
Alumina	0.00121
Silica	0.01930
Carbonic Acid	0.87802*
Nitric Acid	0.01262
Sulphuric Acid	0.01100
Iodine	0.00067
Bromine	0.02158
Chlorine	2.19795
	6.18374
Deduct the equivalent of Oxygen for Chlorine, Bromine, and Iodine	0.49877 gr.
Leaves	5.68497

This amount corresponds nearly with 5.657 gr. of the weight of the residue obtained from 1000 gr. of the Mineral water, but which had already sustained a loss by decomposition. The above quantity of the Carbonic Acid Gas united to the bases has been ascertained by calculation; but its quantity was likewise determined by the following process, in order to see how near the calculation corresponded with the result of the same. 1500 gr. of the Mineral water were boiled for a quarter of an hour in a glass ball, in order to expel the free Carbonic Acid Gas. After the fluid had become cold the glass ball was, with care, filled up nearly with distilled water (previously boiled) so as to remain above the surface of the Mineral water. The connecting tube, which was to convey the Gas from the glass ball to the measuring tube, was now put in its proper position, but not yet attached to the glass ball. A small glass tube of one-6th in. bore and closed at one end, was filled with an adequate quantity of concentrated Sulphuric Acid (more than sufficient to change the Carbonates of the Mineral water into Sulphates,) and suspended by a silken thread it was lowered into the Mineral water, contained in the glass-ball. The glass tube was made to lean against the side of the glass-ball, below the surface of the distilled water, and above that of the Mineral water. The connecting tube, already attached to the measuring tube, was now carefully fixed to the glass-ball, after which the glass-ball was gently shaken until the little glass-tube was upset and had emptied its contents into the Mineral water. The Gas began to collect itself in the measuring tube, and by the application of heat, the whole quantity of the Gas was expelled from the Mineral water. Thus was received 3.45 cubic in. of dry Carbonic Acid Gas at 60 deg. thermometer and 30 in. barometer, which is equal to 1.60760 grs. of Carbonic Acid Gas, making for 1000 grs. of the Mineral water 1.07173 grs. of Carbonic Acid. If we deduct from this amount the quantity of Carbonic Acid Gas found by calculation (1.07173—0.87802) we have a surplus of 0.19371 grs. By calculating the quantity of Carbonic Acid united to the Soda, the latter has been taken as a sub-carbonate; but in the above experiment it was in the form of a sesqui-carbonate, as it is well known that when alkaline bi-carbonates are boiled they change only into sesqui-carbonates, which must naturally increase the quantity of the carbonic acid gas. Besides, the process of determining the quantity of the carbonic acid gas is not so certain and the complicated calculation of transferring measure into weight adds to the difficulty.

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* Combined with Soda, Lime, Magnesia, Strontia, Iron and Manganese.

If we compute the above Acids and bases to binary combinations, in the ratio of their mutual affinities, the Saratoga Congress Water will be found to contain as follows:—

	In 1000 gr.		In 1 pint, 34.659 cub. inch.
Sulphate of Potassa	0.02395	—	0.21040
Chloride of Potassium	0.28223	—	2.47939
Iodide of Sodium	0.00080	—	0.00703
Bromide of Sodium	0.02801	—	0.24607
Chloride of Sodium	3.41412	—	29.99305
Chloride of Ammonium	0.00566	—	0.04972
Nitrate of Magnesia	0.01743	—	0.15312
Carbonate of Soda	0.14342	—	1.25994
———— Lime	1.01616	—	8.92697
———— Magnesia	0.71450	—	6.27688
———— Strontia	0.01167	—	0.10252
———— (Proto) of Iron	0.00301	—	0.02644
———— (Proto) of Manganese	0.00350	—	0.03075
Alumina	0.00121	—	0.01063
Silica	0.01930	—	0.16955
	5.68497 gr.		49.94246

At 50° the natural temp. of the Spring	Carbonic Acid Gas	39.609 cub.in.
	Atmospheric Air	0.458 cub.in.

Bromine is here combined with Sodium : still it is very probable that some portion of it may be united with Magnesium, for by heating the soluble Salts above the temperature of 212 deg., a disengagement of Bromine took place, and a small proportion of Magnesia was separated. The Chlorine is chiefly combined with Sodium ; yet we may nevertheless assume as beyond doubt, that there exist small proportions of Chloride of Calcium, Magnesium, etc., as the degree of chemical affinity is influenced in some measure by the chemical mass, according to the well elucidated theory of Berthollet. We may also presume that the same influence affects those ingredients which are present in smaller quantities, although we are unable at present to ascertain how far and in what proportion the chemical affinity will be influenced by the chemical mass. It is therefore requisite to determine the combinations of the ingredients in conformity with the results of the Analysis.

G. SCHWEITZER.

Royal German Spa, Brighton.
March, 1838.